2 Mathematical Books

AN

# ESSAY,

WHEREIN A

# METHOD

IS

## Humbly Propos'd

FOR

## *Measuring equal* TIME

With the utmost Exactness;

Without the

Necessity of being confin'd to Clocks, Watches, or any other HOROLOGICAL MOVEMENTS; in order to discover the LONGITUDE at SEA.

By James Clarke M.D.

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*LONDON.*

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15 Oct.

GR.DU.III.
PALMUS

THE

# DEDICATION.

TO

The Right Honourable THOMAS Earl of *Pembroke* and *Montgomery*.

The Right Reverend Father in God PHILIP Lord Bishop of *Hereford*.

The Right Reverend Father in God GEORGE Lord Bishop of *Bristol*.

The Right Honourable THOMAS Lord TREVOR.

The Admirals of the *Red*, *White*, and *Blue* Squadrons.

The First Commissioner of the Admiralty.

The First Commissioner of the Navy.
The First Commissioner of Trade.
The Master of *Trinity-House.*
The Honourable Sir THOMAS HANMER Baronet, Speaker of the Honourable *House of Commons.*
The Right Honourable General STANHOPE.
The Honourable FRANCIS ROBARTS Esq;.
Sir ISAAC NEWTON President of the Royal Society.
WILLIAM LOWNDES Esq;
WILLIAM CLAYTON Esq;
Mr. JOHN FLAMSTEAD Astronomer Royal.
Dr. EDMUND HALLEY *Savilian* Professor of Geometry.
Mr. JOHN KEILL, *Savilian* Professor of Astronomy.

Mr.

Mr. SANDERSON, *Lucasian* Professor of the Mathematicks.
Mr. ROGER COTES, *Plumian* Professor of Astronomy.

*Commissioners appointed by Act of Parliament for the Discovery of the* LONGITUDE.

My LORDS and GENTLEMEN,

*AS well out of a hearty Zeal to contribute all that lies within my slender Capacity towards the Service of the Publick, as from the Encouragement lately given by Act of Parliament, I have presum'd to lay before your* HONOURS *this short Scheme, tho' imperfect and immethodical, which for Want of Time and Ability, I am forc'd to send abroad thus naked, and incorrect. Such as it is, I humbly submit it to your* HONOURS *Examination, and if, upon enquiry, it shall be*

*found, in the leaſt Degree, to anſwer the End it aims at, I ſhall think the Time, I have ſpent upon it, well employ'd: It is an infinite Satisfaction to me, when I conſider this Propoſal is to be laid before Perſons of the greateſt Honour and Learning, whoſe Judgment and Juſtice may be rely'd upon with the utmoſt Security. I am,*

*My Lords and Gentlemen,*

*Your* HONOURS

From *Calne* in *Wilts, October* 15. 1714.

*Moſt Obedient*

*Humble Servant,*

James Clarke.

A N

AN

# ESSAY,

WHEREIN

*A Method is humbly propos'd for Meaſuring equal Time, in order to diſcover the Difference of* LONGITUDE *by Sea.*

WHAT is underſtood by the Difference of Longitude, is generally ſo well known, that a particular Deſcription of it in this Place, would be altogether uſeleſs, and impertinent to the Deſign of this Paper; ſince 'tis evident from the known Properties of the Sphere, as well the Celeſtial as Terreſtrial, and the Nature of Time compar'd toge-

ther, that if any Way could be found to meaſure the latter equally, whether it were by Watches, Spring-Clocks, pendulous Movements, or any other kind of Chronometers, or Horometrical Inſtruments; the Longitude might thereby be determin'd with great Eaſe, Expedition and Exactneſs: But, hitherto, no ſuch Movement (that we know of) has been diſcover'd, that will not be liable to be influenc'd by the various Changes of the Atmoſphere: Nor is it likely that any Thing of this kind will be produc'd, ſo as to be exempt from all the common Accidents that attend the Changes of the Air, in the ſame, and different Climates: Upon this Suppoſition, there remains only ſome certain Method to be diſcover'd, which will be free from all the uſual Inconveniences; To which end I concluded, nothing would contribute more, than ſome Way of draining off a *Stagnum*, or certain Weight of ſome ponderous Fluid, by the Means of a tranſparent Syphon, or Glaſs Crane, into ſome proper Receiver, that might be ſo order'd as not to be conſiderably affected by the different Gravity, or other Changes of the Atmoſphere; which Fluid ought to be ſo proportion'd in Quantity, as to



meaſure

measure out a pretty good Period of Time, otherwise it will be too troublesome for Practice, and subject to frequent Mistakes and Oversights, without indefatigable Care and Pains. Now the most ponderous fluid Body that Nature affords us, is Mercury, of which, by a cursory Tryal made with a small glass Syphon, I could nearly guess, that about ninety Pound weight would well enough suffice for a *Stagnum*, or Reservoir, to measure a Period of three Hours, in equal Time: For by draining off a little *Stagnum*, in the Manner before describ'd, I found that about $\frac{3}{4}$ of a Pound of Mercury would Measure just two Minutes of Time; but in this I will not pretend to be very precise, but must leave the Determination of the just Quantity to further Tryals: And because a great many critical Circumstances may occur when a Theory comes to be put in Practice, which may not perfectly Square with the first Conceptions of the Projector, certainly no Man can offer his Thoughts with too much Caution and Modesty; and therefore I shall not be very particular in describing the Structure of an Instrument for this Purpose; but only propose such a general Scheme, as future Industry

duſtry (if the Method be found practicable) may, in a very ſhort Time, improve to perfection.

The firſt Inſtrument I caſt my Thoughts on, was to conſiſt of a Curvilinear Syphon, or Crane of indifferent thick Glaſs, and entire, which was to be bent to a pretty ſmall Angle, and to have one end of it immers'd in a Stagnum of Quickſilver, and the other perforated with a ſmall Hole, or Out-let, to drain off the Mercury into proper Receivers, beſides ſeveral other Requiſites; but I found this Invention (not to ſay any Thing of the great Length of the Syphon, which would have been a mighty Incumbrance), muſt have conſiſted of ſuch a Number of Parts, and taken up ſo much Room, that I could not very well conceive it reconcileable to the Practice at Sea; but I cannot (at preſent) ſee any reaſon why the following Contrivance may not; for the Structure of the Inſtrument is very plain and eaſy, and the Uſe of it not attended with half the Trouble, Caſualty, and Difficulty as the Former would have been; for in this you will not need above three Glaſſes, or four at moſt and thoſe, ſuch as (I conceive) will not be very difficult to make: The firſt muſt

muſt be a kind of a Conoide, and contain the Stagnum or Body of Mercury; this Stagnum or Reſervoir muſt be continually drain'd thro' a very little Hole, or Out-let, that the Current of it may be confin'd to a very ſmall Stream, and ſo the Expence of a profuſe Quantity avoided; to which another Reaſon may be added, and that is, it will be leſs Subject to be affected by the different Preſſures of the Atmoſphere upon the Surface of the Mercury in the Reſervoir; nor will the Hole, tho' as ſmall as a Pin-Hole, (as far as I am able to judge, by the Experiments I have try'd) be liable to be obſtructed in any ordinary Poſition, if the Veſſel and Mercury be clean and dry. The other Part, of which this Inſtrument is to conſiſt, in the ſecond Place, muſt be a convenient Receiver of a Cylindrical Figure, which the upper Glaſs, that is to hold the Mercury, muſt be let into, of a convenient Depth; which upper Glaſs, or Conoide muſt end in a Cylindrical Tube, like that of a Barometer, and be clos'd at the End in the ſame Manner; as near to which as poſſible muſt the ſmall Out-let be made with the greateſt Care and Exactneſs. In fitting of theſe two Glaſſes,

'twill

'twill be requiſite to have the Cylindrical Tube of the one, ground to the Bore of the other, which will require their Necks to be made of a pretty good Thickneſs: Now, if it be at any Time requir'd to put an entire Stop to the Current of the Mercury into the firſt Receiver, or the lower Part of this Clepſydra or Horometer; it may (in my Opinion) be eaſily manag'd after this Manner:

Let a Cylindrical Stopple be ground and fitted exactly to the Bore of the Cylindrical Tube of the Conoide, or upper Glaſs, ſo, as exactly to ſhut the Out-let, and then let a Chanel be cut into it, thro' its whole Length; which done, let the upper End of it be faſten'd into a Stick of Ebony, in order to turn it round at pleaſure, when ever you have a Mind to put a Stop to the Current: Upon which Account, it will not be ſo material, whether the upper and lower Glaſs be fitted to each other by Grinding, provided they are well adapted; the ~~third~~ ſecond ~~and laſt~~ Veſſel or Receiver muſt alſo be an ~~exact~~ Cylinder or call'd Glaſs, except near the Bottom, which ought to end in a Cone, where ſhould be inſerted a kind of a Stop-Cock, made either of Glaſs, Cryſtal

ſtal or Agate, as like as may be to the following Deſcription; Let the Tube of this Cock be made of a rectilinear Figure, and bent to a Right Angle, at the lower End of which, an Out-let muſt be made, of the ſame Diameter, and in the ſame Manner as the former; then let a Piece of Cryſtal be bor'd thro', in ſuch manner as to receive the Tube of the Stop-Cock, which muſt be ſo exactly fitted as to deny an Entrance to the Mercury, whenever you pleaſe; but here you muſt obſerve alſo to have the End of your Stop-Cock cloſe and entire, as was ſaid of the former perforated Tube, and let both the containing, and contained Tubes be of an equal Length, or at leaſt, let the Exterior comprehend ſo much of the Interior as to allow you ſufficient Space, without the Mouth of your laſt Receiver, to turn it round, by a Knob or a Notch made in the Rim, ſo as to bring the Cleft, or Chanel (that muſt be made in it) right over the Hole of the Stop-Cock, in order to open or ſhut the Current of the Mercury at Pleaſure. The abſolute Neceſſity of commanding the Current of Mercury, in order to an exact Computation

of

of equal Time, has drawn this Deſcription to a greater Length than I at firſt intended.

The next Thing to be conſider'd is, what Objections this Scheme may be likely to meet with; and here I find two pretty formidable ones preſent themſelves; the firſt of which is, tho' the Inſtrument were ſuppoſed to ſtand in an immoveable Situation, the Preſſure of the Atmoſphere would alter the Velocity of the Mercury: And the other is, that, by the Motion of the Ship, the Columns of Mercury would have a different Gravitation, according to the different Poſitions it muſt fall into. The former of theſe Objections (I conceive) will not be found to have ſo much Weight in it, as ſome may at firſt be apt to imagine, if we conſider the exceeding Narrowneſs of the Out-let, upon which Account that the Mercury can deſcend no faſter, than in Proportion to its Eſcape thro' the Vent, which appears to be always in one uninterrupted Stream, let the Preſſure of the Atmoſphere upon the Stagnum be what it will: But if it be objected again, that the Stream may happen to be greater, or ſmaller, in different times, tho' it paſs

thro'

thro' the ſame Orifice, and conſequently the Velocity of its Deſcent in the Tube, encreas'd or diminiſh'd, which would overthrow all Certainty; to this I reply,

However this may hold good in other Fluids, conſtituted of diſſimilar Parts, I am almoſt confident it cannot in this, whoſe conſtituent Parts are homogeneous, and extremely poliſh'd, and for that reaſon not capable of being obſtructed in their Paſſage even thro' a very ſmall Orifice; and if ſo, an equal Number of Globules, of the ſame Bulk, muſt neceſſarily fill an equal Space, in equal Times; and conſequently the Current muſt be equal, and continual, which ſufficiently ſupports the Anſwer to the firſt Objection.

As to the ſecond, that, indeed, is a very conſiderable one, and carries ſo much Weight in it, that unleſs it can be got over, it threatens the Ruin of the whole Scheme; which is, That the Columns of Mercury in different Poſitions, will have different Gravitations, and conſequently that the Current of the Mercury muſt be ſo affected by it, that when the Ship with a brisk Gale, and ſide Wind, reclines or leans very much from

a Perpendicular, and remains for a conſiderable Space of Time in that Situation, the Mercury muſt be very much retarded in its Motion thro' the Vent, if not wholly reſtrain'd, in regard the Centripetal Force will be diminiſh'd in Proportion to the Reclination of the Columns of Mercury; to produce which reſtraint of Motion in the Mercury, the Weight of the incumbent Atmoſphere and Reſiſtance of the ambient Air may ſomewhat contribute.

Now, to ward againſt this mighty Inconvenience (if it ſhould prove to be ſo in fact) I cannot think of a better Expedient (by which the Mercury may be kept ſo near a Perpendicular under all the various Motions of the Ship occaſion'd by the Winds and Waves, as not to alter its Current) than to have the whole Frame of this Horometer ſuſpended by a ſtrong Rope, of no great Length, in ſome convenient Place of the Ship: Nor will the ſame Objection lie againſt this, as may be brought againſt Seignior *Dorotheo Almari*'s Cylinder, deſign'd to take an Altitude of the Sun by, for in his Operation great Exactneſs is requir'd, even to Seconds of Time; and a very ſmall Variation

riation of the Inſtrument from a Perpendicular will fruſtrate the Operation, by altering the Length of the Shadow; but in this the Shifting an Angle will be inſignificant, and make no Impreſſion on the Current of the Quickſilver in General, or variation of Time in the Evacuation, nor will it be attended with that Inconvenience, which the exhauſted Spheroide propos'd by Mr. *Hawkins*, may be liable to; for without all Doubt, that muſt fill too quick to meaſure uſeful Periods of Time; beſides which, if it ſhould be affected by the Changes of the Air, I can't ſee how it can be compleatly regulated; and therefore, tho' the Conception is pretty enough, there is ſtill ſome reaſon to doubt, whether it is reducible to practice. But after all that has been ſaid, if it ſhould be deny'd that the Current of the Mercury can be the ſame under every Condition of the Atmoſphere, but that it muſt vary more or leſs, tho' it be not eaſily diſcover'd by the Eye, and conſequently muſt cauſe unequal Quantities of Mercury to be exhauſted in equal Times, if it ſhould be ſo, I am perſwaded the Diſproportion muſt be very inconſidera-

 ble,

ble, and if not, could be eaſily computed, and adjuſted by the Help of a good portable Barometer, for by obſerving at what height of the Barometer, ſuch a Quantity of Mercury is exhauſted in ſuch a Period of Time, 'twill be eaſy to make a Table of Equation to the greateſt Exactneſs.

Having (as I hope) indifferently well got over theſe principal Difficulties, I am in the next Place to conſider, what leſs material Objections may yet lie in my Way. One of which, perhaps, may be, that the Veſſels being made of brittle Materials, will be liable to almoſt infinite Accidents.

This is ſo weak and trifling, that it ſcarce deſerves an Anſwer, ſince 'tis very eaſy to ſecure thin Glaſs in Frames of Braſs, Wood, or Iron, contriv'd ſo with Hoops and Braces, as to allow ſufficient Space to view the Mercury thro': Beſides, theſe Veſſels are propos'd to be made of fine Glaſs, of a pretty good Thickneſs and Strength.

But if it be ſaid, the Moiſture of the Air will be apt to diſorder the Motion of the Mercury: That is no more than to ſay, it will be affected by it as it is in

common

common Barometers; which meets with its Answer, in the Answers to the former Objections.

Another Inconvenience, that may be objected is, that the Mercury is requir'd to be kept clean, and free from Dust, or any additional Moisture, such as Water accidentally falling upon its Surface, which will be difficult to do: In answer to which I can only say that this, in my humble Opinion, will be attended with no more Difficulty, than what must be necessary in securing, Watches and Spring-Clocks, Pendulous Movements, or most other Instruments and Utensils, that seem to require the same Care, and that is, by proper Covers or Cases, which (with several other Appendices) must be left to the Ingenuity and Contrivance of proper Artificers, when the Thing comes to be try'd.

What Reception this imperfect Sketch will meet with, I cannot pretend to foresee: For, by the by, I must own, I have not had Leisure, and perhaps, not skill enough to make such a competent Number of curious Experiments, as might enable me to judge of

the Fate of ſuch an Undertaking, ſo that if any Thing of this Nature has been already try'd, and found unſucceſsful, the Knowledge of it may very well eſcape me, and if my Ignorance of ſuch Matter of Fact, ſhould expoſe this Propoſal to be cenſur'd; I may, however, reaſonably expect ſome Quarter from the ſevereſt Criticks, if it were but upon the Account of an innocent Zeal I have expreſs'd to ſerve the Publick: But if on the contrary this Method ſhould be found practicable, I believe, every one muſt allow, there will, then, be nothing more left to compleat the ſo much wiſh'd for Diſcovery of Longitude, both by Sea and Land, but a demonſtrative and practicable Method of finding the ſame by Aſtronomical Obſervation alſo:

Which (if I am not very much miſtaken) from ſome Experiments lately made; I have good reaſon to believe very feaſible.

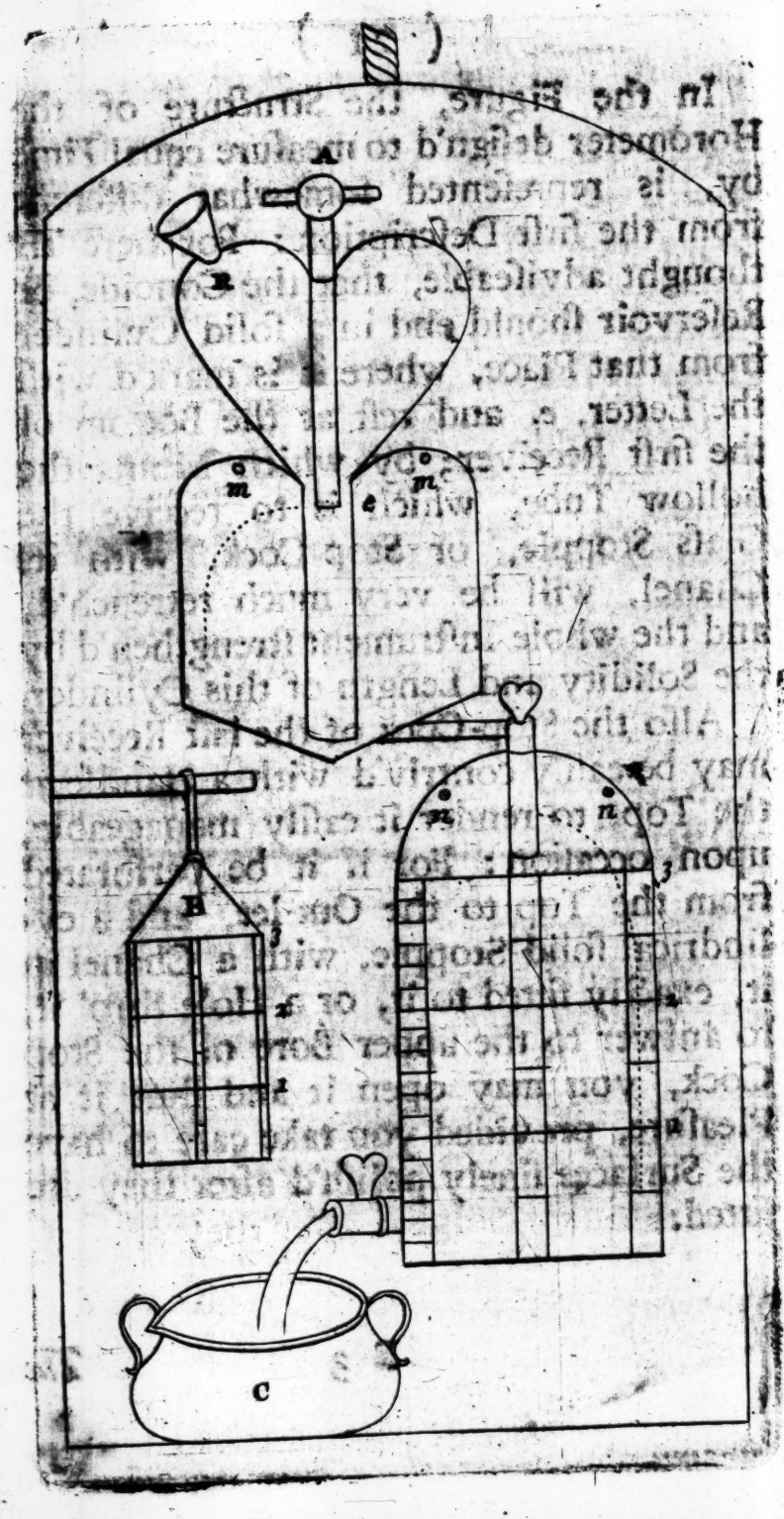
But this muſt be reſerv'd till it can be brought to a Geometrical Demonſtration.

Which I am now endeavouring at.

In

In the Figure, the Structure of the Horometer design'd to measure equal Time by, is represented somewhat different from the first Description: For here 'tis thought adviseable, that the Conoide, or Reservoir should end in a solid Cylinder from that Place, where it is mark'd with the Letter, *e.* and rest at the Bottom of the first Receiver; by which Means the hollow Tube, which is to receive the Glass Stopple, or Stop-Cock, with its Chanel, will be very much retrench'd, and the whole Instrument strengthen'd by the Solidity and Length of this Cylinder.

Also the Stop-Cock of the last Receiver may be easily contriv'd with a Handle at the Top, to render it easily manageable, upon occasion: For if it be perforated from the Top to the Out-let, and a cylindrical solid Stopple, with a Chanel in it, exactly fitted to it, or a Hole thro' it, to answer to the upper Bore of the Stop Cock, you may open it and shut it at Pleasure, provided you take care to have the Surfaces finely polish'd after they are fitted:


A
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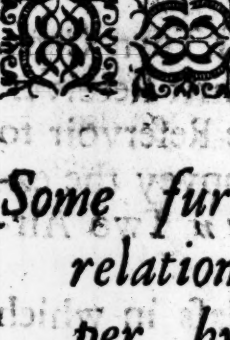
*The Explanation of the Figures.*

(*A*) The Handle of the firſt Turn-Cock. *m m* Two Air-Holes in the firſt Receiver. (*R*) A Hole at the Top of the Reſervoir to receive a Glaſs Funnel to reconvey the exhauſted Mercury into it. *n n* Two Air-Holes in the ſecond Receiver.

*B.* Another cylindrical Glaſs in which the Mercury may be weigh'd or eſtimated.

*C.* A Pot of Earth to drain it off in Parts.

## *Some further Conſiderations in relation to the foregoing Paper, by Way of Appendix.*



INCE the former Paper was writ, upon making an Experiment or two, ſome new Conſiderations have ariſen, which require to be taken ſome Notice of.

In the firſt Place, it may be ask'd, after what manner has the Author of this Eſſay propos'd to eſtimate a certain Period of Time by the Quantity of the exhauſted Fluid, with the Exactneſs requir'd in keeping equal Time; ſince the horizontal Surface of the moſt ponderous Fluid will, in all Probability, be diſturb'd by the Motion of the Ship, ſo as not to be always at right Angles with the Sides of his Veſſel?

As to this, the Author has propos'd two

two Ways of doing it, by Inſpection, in order to which, he is to make uſe either of a cylindrical or ſpherical Receiver: If the former, then it muſt be included in a braſs Frame, like that of a Lanthorn, whoſe Ribs muſt ſerve as Scales of Altitude, and be graduated ſo, as to contain the Hours, Minutes, and Seconds, to the ſeveral Segments of the Cylinder, which by frequent Tryals may be eaſily made; or it may be ſo contriv'd, that in juſt ſo many equal Hours, it ſhall be fill'd exactly to ſuch a Degree of Altitude, and then taken off and empty'd into the Reſervoir. If the latter, then he muſt provide himſelf with a Semicircle of Altitudes divided in the ſame Manner, reſembling that which is apply'd to the Globes.

Now the Inſtrument will be eaſily brought near enough to a Perpendicular, and kept there long enough to determine an Altitude, but if this be thought liable to any conſiderable Error; the laſt and ſureſt Way, is to weigh the Mercury in an exact Balance, either graduated in Hours, Minutes, and Seconds, or the common Way. But if it be perform'd by Scales, it muſt be done over the Sur-

face

face of Water, which will always keep Horizontal.

The next Queſtion will be, how the Author propoſes to eſtimate the Time that will elapſe whilſt he is determining the Quantity of the evacuated Mercury, (if that were at all Times neceſſary) and repleniſhing his Reſervoir, in order to begin a new Computation: For if it be done by any Horological Movement, whether it be mov'd by Spring or Pendulum; we are told, the Objections uſually brought againſt thoſe Movements, will lie very ſtrong againſt this Operation, which is their Poſſibility of Variation from equal Time.

In Anſwer to this, the Author takes it for granted, that any Operation of that kind, cannot (at the moſt) take up above ſix Minutes of Time, which he thinks may be eſtimated ſomewhat near to a Certainty, by a Movement, made only to meaſure Minutes, and Seconds, which would be the ſpeedieſt Way: But if this be diſputed, he is perſwaded it may be determin'd by another Clepſydra, of a leſſer Size, which may be employ'd to eſtimate the Parts of Time elaps'd; but it muſt be ſet going the very Moment the greater

is ſtop'd by its Turn-Cock; by which means, the Uſe of any Sort of Movements might be omitted; and a Space of three Hours of equal Time exactly determin'd, and ſuch a Space ſeems to be requir'd, in order to avoid abundance of Trouble and Attendance, with a great many other Inconveniences, which could not be avoided in ſhort Periods of Time.

If any other Objections remain beſides what are here taken Notice of, I am perſwaded they cannot be of ſuch Moment, as conſiderably to affect this Propoſal. By an Experiment I lately made, I found ſomewhat above three Quarters of a Pound, *Averdupoize*, of Mercury, meaſur'd exactly two Minutes, as near as could be gueſs'd, by the Movement I made uſe of, and by repeated Tryals I could not find any Difference in the Time of its Diſcharge, tho' I wav'd it up and down, and chang'd it almoſt into all Poſitions, except that which is parallel to the Horizon, during the whole Time it was running. Theſe Experiments, imperfect as they are, ſeem not ſo inconſiderable, as to be totally rejected; but rather, in all Probability, would give Encouragement to Gentlemen of greater

Skill

Skill and Ability, to make further Tryals with more Niceneſs and Accuracy: For, if once an exact Way to meaſure equal Time can be come at, if there were no other Diſcovery, this alone, (in the Opinion of all) would be ſufficient to determine the Longitude, or difference of Longitude.

But now, in the laſt Place, I expect to meet with an Objection, which I had almoſt forgot, and that is, Let this Method be ſuppos'd to ſucceed never ſo well in the Buſineſs of keeping Time; it will, withal, be ſo troubleſome and difficult to manage, that 'tis much to be fear'd, 'twill hardly be practicable at Sea, becauſe of the great Weight of the exhauſted Mercury, which is requir'd to be return'd into the Reſervoir. To which I anſwer: This Labour is to be repeated not above once in two, or three Hours at the moſt; and beſides, if the whole Weight of the laſt Receiver be thought hardly manageable, it may be drain'd off in Parts, into a large Earthen-Pot, with a Lip in it, and ſo eaſily reconvey'd by the glaſs Funnel in a very little Time; all which may be done by having a Turn-Cock in the Bottom of the laſt Re-

Receiver, to drain off a large Quantity very ſpeedily. But notwithſtanding all that has been ſaid before upon this Subject, I am very well aware ſome Scruples may ariſe about the exact Calculation of Time by the Quantity of the exhauſted Mercury: To anſwer this particularly, would ſwell this Paper beyond its intended Bulk, which indeed was only deſign'd to give ſome rational Hints towards the Improvement of Navigation; but this, I think I may venture ſafely to aſſert, that let the Fate of all the other Ways herein propos'd, be what it will, it is demonſtratively certain, (upon ~~the~~ Principles ~~before laid down~~), that the Weight of any greater or leſſer Quantity of Mercury exhauſted thro' an Orifice of the ſame Diameter, will be in Proportion to the Times of its Evacuation: So that by Weighing any given Quantity, by the Rule of Proportion you may exactly know how many Hours, Minutes, Seconds, *&c.* have elaps'd during the Time of its Evacuation: And (I ſuppoſe) it cannot be thought a Matter of any great Difficulty to procure an exact Balance, which indeed is the only exact Method that can be us'd, and will by Practice be rendred very ready and familiar. To

To conclude all: If this Method ſhould be found practicable, and the Brittleneſs of the Materials which compoſe the Inſtrument, ſhould be thought a good Objection againſt the putting it to the Experiment; this ſeeming Difficulty can eaſily be got over, by this one Expedient, and the whole ſo contriv'd, as never to be liable to the leaſt Accident, without the greateſt Negligence. Which is, to have the Veſſel that is to hold the Stagnum, and the Receiver under it, fitted into each other by the Means of a Screw, and both made of ſtrong and durable Wood, ſuch as *Lignum-Vitæ*, or the like, finely poliſh'd within. All the Difficulty in this, will be how to finiſh the Inſide of this Receiver, which muſt in all reſpects be like that of Glaſs before deſcrib'd; and this (I think) alſo may eaſily be done, by having it made to ſcrew, or take off in two Parts, and afterwards, when the Parts are all fitted together, never to be taken aſunder, unleſs ſome extraordinary Accident requires it.

But in the lower End of this Reſervoir, or Conoide of Wood (which may alſo be contriv'd of any other Shape, as ſhall be found moſt convenient) muſt be fitted a hol-

a hollow Tube of thick Glaſs, Cryſtal or Agate, whoſe Bore muſt be exactly fitted to the cylindrical Stopple, which is to be faſten'd into a Stick of Ebony, as was mention'd before, where the firſt Turn-Cock was deſcrib'd, and therefore need not be enlarg'd upon in this Place: And to ſtrengthen this Inſtrument, you may have it hoop'd with Braſs or Iron, ſo as to ſuſtain any Weight or Shock whatſoever. But you muſt take Care that the Tube of Cryſtal, Agate or Glaſs, with the Stop-Cock belonging to it, muſt ſo much exceed the Length of that part of the Screw of your Reſervoir, as to enter within the Hollow of the Receiver or under Part, ſo that it may not obſtruct the Out-let. If your Veſſels are made pretty cloſe, ſo you do not wholly exclude the Air, you need not fear any Obſtruction to the Current: This Inſtrument can be made of no other Subſtance, but Wood or Glaſs. For all Metals will more or leſs be prey'd upon by the Mercury, by which Means its Texture will be alter'd, and its Lubricity taken off, and ſo in Time it will be render'd unfit for Uſe.

POST-

# POSTSCRIPT.

SInce the Author had finish'd this ſmall Treatiſe; upon ſecond Thoughts he has conſider'd, there may be ſome Difficulty in the mechanical Structure of the Inſtrument it ſelf, and probably ſome Trouble and Danger of waſting the Mercury, in the Management of it, eſpecially in a great Storm: To avoid both which Inconveniences, he thinks it, in the firſt Place, adviſeable to have the Stopples, which are to run in the hollow Part of the cylindrical Tubes of the Turn-Cocks, made all of Box or Ebony, or ſome ſuch cloſe and durable Wood, inſtead of Glaſs, Cryſtal, or Agate, which was firſt propos'd: But the cylindrical Tubes, which are to receive them, muſt (he thinks) conſiſt of ſome ſuch hard and poliſh'd Body, as was before deſcrib'd, to anſwer the End of keeping the Current free and uninterrupted.

And to provide againſt the Hazard of Spilling the Mercury, ſome Way may eaſily be contriv'd to draw up any Weight of Mercury evacuated into a proper Receiver, ſecur'd in a Frame of Iron or Braſs, by the Means of a Pully and a Rope, or Chain faſten'd at one End to the Frame of the Receiver, and at the other End to ſome Hook or Beam fix'd within the outward Caſe or Frame, including the Horometer: And when the Receiver with the contain'd Mercury is raiſed by the Pully to a convenient Height, it may be tilted and empty'd into a capacious Funnel of *Lignum Vitæ*, or any other proper Wood, made of a Figure ſuitable to the Purpoſe, and thus it may be ſafely reconvey'd by letting the ſmall End of it enter, a convenient Depth, into the Mouth of the Reſervoir. And to the End it may be taken off and put on at Pleaſure, ſome fix'd Frame muſt be contriv'd within the Frame or Caſe of the Horometer: Which, I think, is all that can be ſaid by Way of Hint, the reſt muſt be left to the Invention of the Artiſt.

FINIS.